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ABSTRACT

The integration of test-banks for computer-based testing, textbooks, and electronic lecture notes in first-year mathematics courses has changed the way mathematics is taught at Bennett College (Greensboro, North Carolina). Classes meet in two electronic classrooms each with 27 computers on a local area network and a projection system. An integrated computerized instructional system (ICISS) has been set up in both labs so that a variety of teaching/learning approaches can be used. The main objective of the system is to involve students in the learning process by avoiding excessive writing on the board, providing information in an interactive mode, and allowing students to explore some concepts through computer software. The system contains a set of extensive test-banks for each course and a graphics editor with many mathematical symbols available is used to add questions or modify questions in the test-banks. The ICISS system includes several programs that support the testing/tutorial process. An eight-digit coding system is used which allows the instructor to select the types of questions selected at random by the computer. The Course Management System produces an electronic grade book, so that scores can be entered into the grade book quickly and easily directly from the file server. Electronic Lecture Notes have been installed for Basic Mathematics, Beginning Algebra, and Pre-Calculus. A summary of the results of student attitudes in a questionnaire about the use of the ICISS materials is provided, as well as sample screens of online review and practice testing. (AEF)

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Integrating a Computerized Testing System and Electronic Lecture Notes in First-year Mathematics Courses

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The integration of test-banks for computer-based testing, textbooks, and electronic lecture notes in first-year mathematics courses has changed the way mathematics is taught at Bennett College. Classes meet in two electronic classrooms each with 27 computers on a local area network and a projection system. An integrated computerized instructional system (ICISS) has been set up in both labs so that a variety of teaching/learning approaches can be used. The main objective of the system is to involve students in the learning process by avoiding excessive writing on the board, providing information in an interactive mode, and allowing students to explore some concepts through computer software. At Bennett the system has been used in varying degrees in courses in Elementary Algebra, Intermediate Algebra, Pre-Calculus, and three semesters of Calculus.

Integrated Computerized Instructional Support System

The Integrated Computerized Instructional Support System was developed by Dr. Man Sharma, the Director of Academic Computing at Clark-Atlanta University. This project has been supported by several grants from the US Department of Education through the Minority Science Improvement Program. Materials are distributed by EDUCO International, Inc. of McDonough GA. Approximately 100 institutions are using or have used these materials. Bennett College has been involved with the ICISS project since 1988.

Question Banks and the Graphics Editor

The first component of the system is a set of extensive test-banks for each course. Most of the questions have hints and solutions so that students can use the test-banks for tutorials outside class or they can be used for short timed quizzes during the class period. Such frequent short quizzes are particularly useful in elementary algebra where quick recall of facts and procedures are tested. Students who do not do well on the first try may be allowed to make up the quiz at the discretion of the instructor. The questions banks have been installed on the network and records of the students' scores on quizzes are kept in "result" files. The instructor can also generate multiple versions of the test to be printed out and used as hard-copy tests. A graphics editor (MEDIT.EXE) with many mathematical symbols available is used to add questions or modify questions in the test-banks.

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File Management and the Test / Menu Generator

The ICISS system includes several programs that support the testing/tutorial process. It is not necessary that the instructor knows how to use these programs, but the laboratory technician will need to spend some time learning the procedures. A file management program (FMS.EXE) helps in the management of the question banks, by indexing the questions, checking technical errors, and creating various subsets and summaries of the test-banks. A test generator (MENUGEN.EXE) generates the tests with randomization on two levels and creates a menu from which students can select appropriate quizzes and practices. The instructor can begin tests for selected periods of time and an electronic class roll prevents unauthorized students from taking the test.

As indicated above, tests may be prepared for students on two levels: review questions with no score and quizzes for which the score is saved. For the review questions (called practice tests), students may practice any number of times and each time different questions will be provided, depending on the number of similar versions in the test-bank. The time spent on the test is recorded but the score is not. So the students may work on questions and study the hints and solutions without worrying about the stigma of getting a low grade.

An 8-digit coding system is used and this allows the instructor to select the types of questions selected at random by the computer. Usually the coding system has the form:
<Course Chapter Section Concept Question No (2 digits) Version Number (2 digits)>
Hence a question with code 21323003 represents the second course (Elementary Algebra), chapter 1, section 3, topic 2, question 30, and version 03. A practice test consists of a collection of four digit codes, so that the instructor can select questions within a particular topic, but the questions and versions are selected at random for presentation to the student. When the student takes the review test (tutorial), hints and solutions are provided, and the student gets immediate feedback. An actual quiz consists of a collection of six digit codes, so that the instructor can select specific types of questions; the only difference between the tests for one student and another is the version of the question. The degree of difficulty of the same quiz given to different students will be the same. Moreover, the amount of time allowed to complete the test is specified in setting up the quiz. When a student takes an actual test, answers can be changed as on a paper test, but the student will not be able to review missed questions and look over the solutions until he or she finishes the test. The students can be directed to show work on paper while taking a test on the computer.

A schematic of the on-line review and practice testing procedures is given at the end of this paper. This test-generating software also allows setting up make-up quizzes. This process uses item-analysis (see below) so that the make-up quizzes are harder than the original tests.

The instructor can prepare printed tests in a similar manner. Several versions can be constructed. The test banks contain some open-ended questions, so that some questions on the printed test can be short-answer rather than multiple choice.

Course Management System, Record Management System, and Item Analysis

The Course Management System (CMS.EXE) produces an electronic grade book, so that scores can be entered into the grade book quickly and easily directly from the file server. This is a

powerful feature for large classes. Besides electronic transfer of scores on tests to the class roll, the course management system allows for manual entering of grades, a wide variety of methods to determine grades, and periodic progress reports to students. These periodic progress reports have proved popular among the students, since the reports indicate to the students exactly where they stand in the class and allow the students to make corrections if some scores are inaccurate. Another program provides an item analysis of the test results for each type of question.

Electronic Lecture Notes

Electronic Lecture Notes have been installed for Basic Mathematics, Beginning Algebra, and Pre-calculus (including College algebra and Trigonometry). Chemistry and Biology Notes are also available for first-year college courses. The electronic lecture notes, (also known as EDUCO Electronic Tutors) are based on Asymmetric's Toolbook. They provide extensive use of dynamic graphs, animation, attractive screen designs, and colorful display of concepts and strategies for solving problems. (See examples of typical screens at the end of these notes).

Text and diagrams are presented a little bit at a time, and the student can "click" on various links or proceed in a step-by-step manner. Examples are worked out in detail with explanations, again one step at a time. The electronic lecture notes can be used by the instructor for display to the entire class as a substitute for the chalk and talk approach. They are particularly effective when animation or visualization is required, such as the secant line approaching the tangent line, the Riemman sum, volumes of revolution, and three-dimensional graphs. Use of the electronic lecture notes allows teachers to stay well organized and informed and to reduce time spent in writing on the board. Since the electronic lecture notes are available to students after the class is over, the students can concentrate on the discussion and do not need to take notes. Electronic Lecture Notes allow the instructor to present a variety of kinds of activities in class. I use them in place of lecture for twenty or twenty-five minutes once or twice a week.

The electronic lecture notes can also be used by students in the computer lab as tutorials complementing class lectures. If a student misses a class, she or he can easily make up the work by using the software. The material corresponds to text book materials. They can also be used as enrichment for material not covered in class for the advanced student. I have prepared guided instructions for students to use the electronic lecture notes, setting out in detail what the students should cover on the computer, asking them to write down the basic results and examples shown, and directing them to work problems similar to those displayed. This approach is particularly useful when I am away from campus or after a quiz. In the latter situation, these guided instructions are used when students finish at various times and can begin studying for the next topic while others finish the quiz.

Textbooks

The textbooks used in Elementary Algebra and Calculus at Bennett are also published by EDUCO International Inc. The organization and scope of the topics in the textbooks are compatible with the test-banks and the electronic lecture notes. These textbooks emphasize a practical approach and are to be used as a supplement to the electronic lecture notes. This allows flexibility to the instructor to provide investigative activities and proofs as is warranted by the nature of the class and

the abilities of the students. Since we can only offer one section of calculus at Bennett, this one class must accommodate the needs of not only mathematics majors, but also students from the sciences, psychology, and business. The use of the tutorial question-banks and the electronic lecture notes for individualized learning allows for teaching students in these diverse disciplines.

MATHCAD

In calculus we use an additional methodology, namely MathCAD, a mathematical software that allows students to pursue the graphical and numerical aspects of the subject material. While many students are familiar with graphing calculators, some are not. With the software students can investigate problems, mathematical concepts, and results numerically and graphically either during a lecture or discussion of homework in class or on their own as a lab exercise. The use of computer software allows for investigations in depth of a problem as well as the opportunity to write explanations and to print out the graph, table, and written material. The technology can be used as an integral part of the process of formulation, solution, and communication.

Student Attitudes

Students have responded to the use of the ICISS materials and the electronic lecture notes in class and in the computer lab in a favorable way. A summary of the results of recent questionnaires follows.

STUDENT QUESTIONNAIRE CALCULUS
Use of Electronic Lecture Notes
SA Strongly agree; A Agree; N No opinion; D Disagree; SD Strongly Disagree

1. Electronic Lecture Notes have been used some days as a partial substitute for the class lecture. This has been helpful in general.
SA 16% A 84% N D SD

2. Electronic Lecture Notes have been helpful in demonstrating limits.
SA 11% A 63% N 16% D SD

3.Electronic Lecture Notes have been helpful in demonstrating the concept of derivative as a slope of tangent line.
SA 11% A 42% N 31% D 16% SD

4.Electronic Lecture Notes have been helpful in demonstrating the concept of derivatives as instantaneous velocity.
SA 11% A 47% N 21% D 16% SD 5%

5.Electronic Lecture Notes have been helpful in demonstrating the concept of related rates (sliding ladders, rising balloons, etc.).
SA 30% A 30% N 25% D 5% SD 10%

6. There was one exercise in which you were asked to go through a topic on electronic lecture notes on your own--the rules for derivatives. This was a good way to work through the ideas and learn the rules on my own.
SA 63% A 26% N 11% D SD

7.Guided assignments for individual use of Electronic Lecture Notes should be given more often.
SA 37% A 32% N 16% D 11% SD 4%

8. The instructor should lecture and go over homework problems and not use Electronic Notes during class.
SA 16% A N 21% D 39% SD 24%

9. I have voluntarily used Electronic Lecture Notes on my own:

Never	Once or Twice	A few times	Frequently
32%	32%	36%	

BASIC ALGEBRA MA 99
Use of the Electronic Lecture Notes and ICISS
SA Strongly agree; A Agree; N No opinion; D Disagree; SD Strongly Disagree

1. Electronic Lecture Notes have been used some days as a partial substitute for the class lecture. This has been helpful in general.
SA 25% A 55% N 5% D 10% SD

2. Electronic Lecture Notes have been helpful in demonstrating solving equations.
SA 35% A 60% N 5% D SD

3. Electronic Lecture Notes have been helpful in demonstrating how to solve word problems.
SA 10% A 60% N 10% D 15% SD 5%

4. Electronic Lecture Notes have been helpful in demonstrating graphing a line.
SA 25% A 55% N 20% D SD 5%

5. There was one exercise in which you were asked to go through a topic on electronic lecture notes on your own--the rules for derivatives. This was a good way to work through the ideas and learn the rules on my own.
SA 35% A 45% N 15% D SD

6. Guided assignments for individual use of Electronic Lecture Notes should be given more frequently.
SD 25% A 45% N 30% D SD

7. The instructor should lecture and go over homework problems and not use Electronic Notes during class.
SA 15% A N 15% D 45% SD 20%

8 The test-bank reviews for each of the topics helped me to prepare for quizzes and tests.
SA 45% A 45% N 20% D SD

9. Frequent quizzes and makeup quizzes helped me to learn the concepts on a regular basis.
SA 35% A 55% N 5% D 5% SD

10. Periodic progress reports form the computer were helpful and should be continued.
SA 55% A 35% N 5% D SD

References

Algebra Part I, by Man Sharma and Ravinder Kumar, (McDonough GA: EDUCO International Inc., 1996).

Pre-Calculus (College Algebra) by Man Sharma and Ravinder Kumar, (McDonough GA: EDUCO International Inc., 1996).

Calculus Part I (Third Edition) by Jagmohan Kapoor and Man Sharma, (McDonough GA: EDUCO International Inc., 1996).

Calculus Part II (Third Edition) by Jagmohan Kapoor and Man Sharma, (McDonough GA: EDUCO International Inc., 1996).

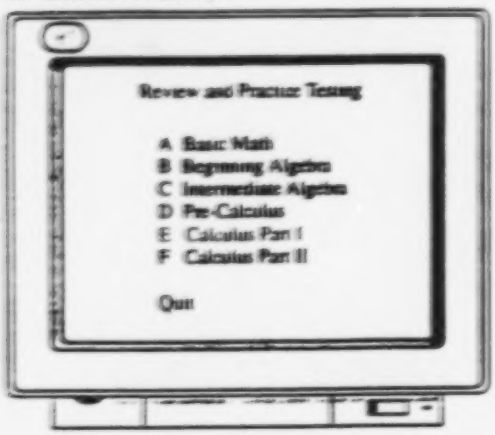
Calculus Part III by Jagmohan Kapoor and Man Sharma, (McDonough GA: EDUCO International Inc., 1996).

ICISS Software and the Electronic Tutor Version 2.0 (which includes courses in Basic Mathematics, Algebra Part I (Elementary Algebra), Pre-calculus, Calculus I, Calculus II, Calculus III, General Chemistry, and General Biology) are available from EDUCO International Inc., 1948 Chambers Rd., McDonough GA 30352. Phone 1-800-963-3826, FAX 1-770-954-9060.

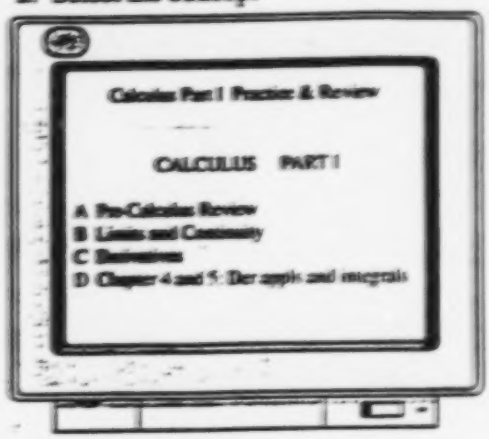
On line Review and Practice Testing

◆ Sample Screens

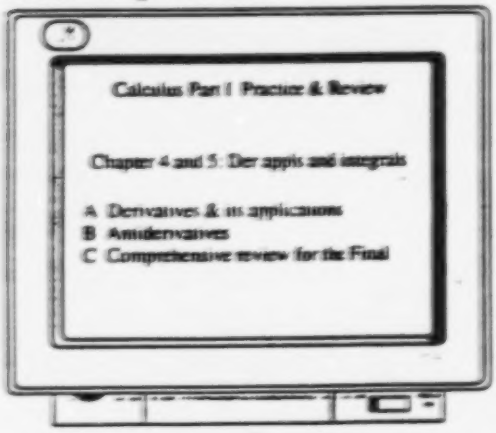
1. Select a course



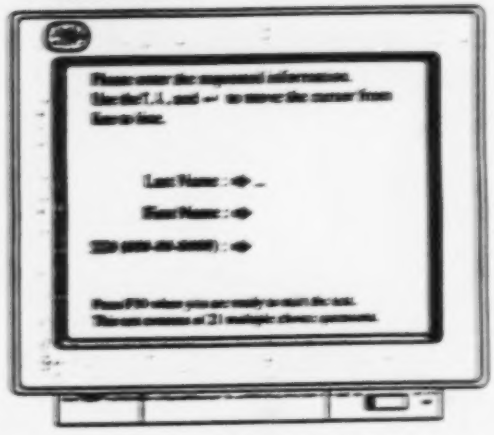
2. Select the concept


Calculus Part I Practice & Review
CALCULUS PART I
A Pre-Calculus Review
B Limits and Continuity
C Derivatives
D Chapter 4 and 5: Der appls and integrals

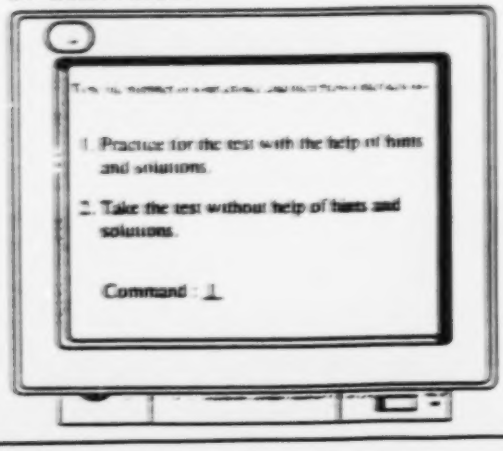
3. Select QUIZ/TEST


Calculus Part I Practice & Review
Chapter 4 and 5: Der appls and integrals
A Derivatives & its applications
B Antiderivatives
C Comprehensive review for the Final

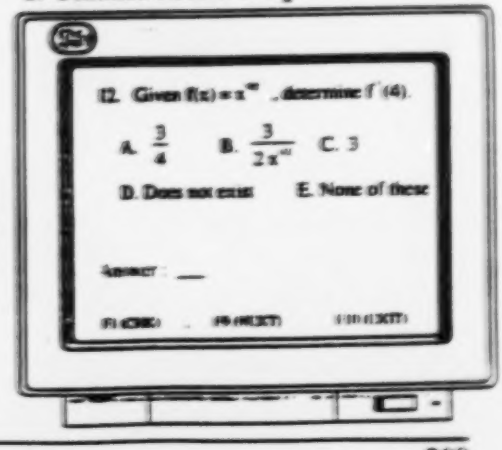
4. Identification



5. Select mode



6. Practice Mode: Response



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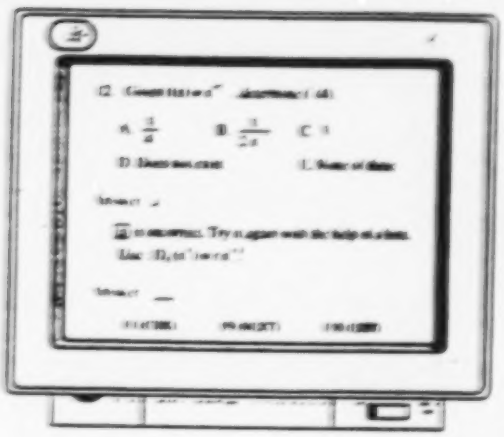
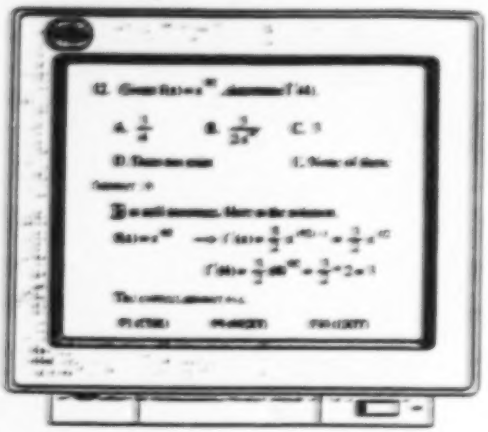
On line Review and Practice Testing

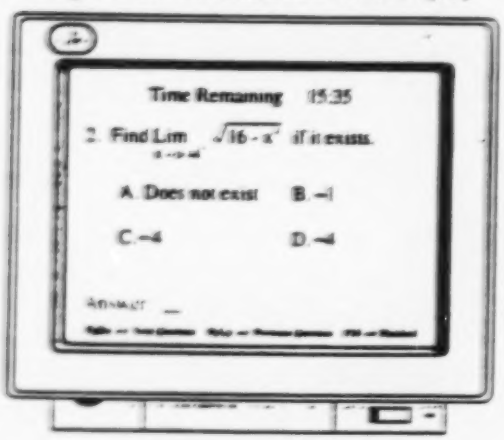
7. Response incorrect: Hint provided



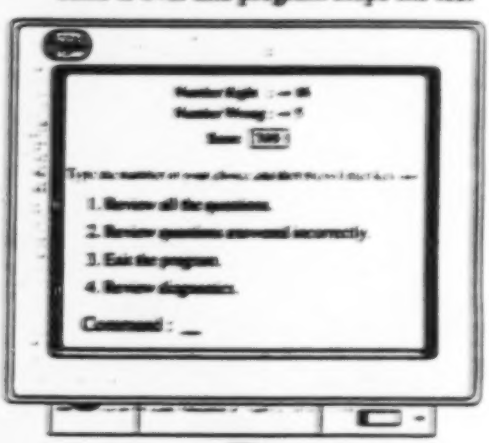
8. Response incorrect again:
Solution provided



9. Test Mode Option:
Option 2 from select mode screen (#5)



10. Test Completed with F10 or
Time is over and program stops the test



- On entering 2 provides solution to the missed items.
- On entering 3 we exit from testing with scores saved in the result file that can be directly transferred to the grade book.

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Ex 3: A conical tank (with vertex down) is 40ft across the top and 10ft deep. If water is flowing into the tank at the rate of 10cu ft/m, find the rate of change of the depth of the water when it is 6ft deep.

Step 1: After time t, BC = depth of water and CD = radius of water cone.

Step 2: The rate of volume of water cone BCD is given, so label it as x

Step 3: We want the rate of change of the depth of water, so we label it as y

Step 4: Volume of water cone:

$$x = \frac{1}{3}\pi(CD)^2 y$$

Volume of a circular cone of radius r and height h is:

$$V = \frac{1}{3}\pi r^2 h$$

Ex 3: A conical tank (with vertex down) is 40ft across the top and 10ft deep. If water is flowing into the tank at the rate of 10cu ft/m, find the rate of change of the depth of the water when it is 6ft deep.

Step 1: After time t, BC = depth of water and CD = radius of water cone.

Step 2: The rate of volume of water cone BCD is given, so label it as x

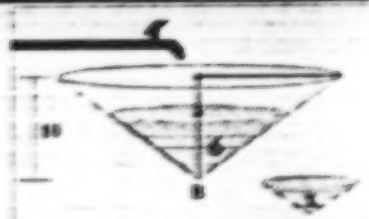
Step 3: We want the rate of change of the depth of water, so we label it as y

Step 4: Volume of water cone: $x = \frac{4}{\pi} y^3$

Step 5: $\frac{dx}{dt} = 4\pi y^2 \frac{dy}{dt}$

Step 6: In the final situation, BC = y = 6 and dx/dt = 10.

Step 7: Substitute in Step 5 and solve.



$$10 = 4\pi(6)^2 \frac{dy}{dt}$$

$$\frac{dy}{dt} = \frac{10}{144\pi}$$

$$= \frac{5}{72\pi} \text{ ft/m}$$

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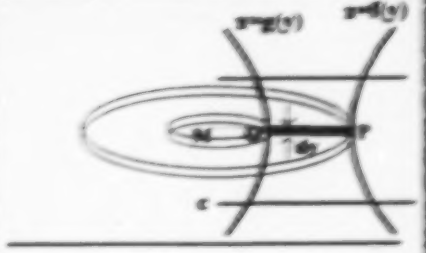
Washer Method/Shell Method

Observation:

When the typical rectangle is perpendicular to the axis of rotation, it generates a 'Washer'.

Let the HS region be bounded by $x = f(y)$, $x = g(y)$, $y = c$, and $y = d$.



Washer Method/Shell Method

Observation:

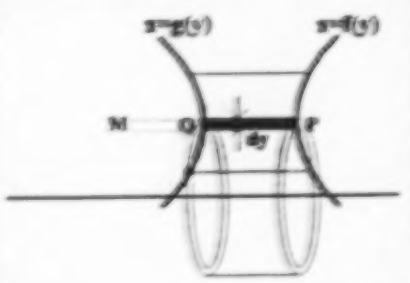
When the typical rectangle is perpendicular to the axis of rotation, it generates a 'Washer'.

When it is parallel to the axis of rotation, it generates a cylindrical 'Shell'.

Notice that the position (either parallel or perpendicular to the axis of rotation) of the typical rectangle will determine the choice of the method -- either Washer Method or Shell Method.

Shell Method

Let the HS region be bounded by $x = f(y)$, $x = g(y)$, $y = c$, and $y = d$.



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